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(54) Shaft seals

(57) A rotary mechanical face seal, especially for marine propeller shaft stern tubes, has a seal face member 6 mounted at the end of a rubber bush 7 that provides the necessary axial thrust on the member 6 and the adjacent end of the bush has a retaining ring 10 that traps part of the rubber and has a shoulder that co-operates with a shoulder on the seal face member 6 so that the axial thrust, transmitted through the trapped rubber, exerts an inward gripping force on the member 6 which may be of slit construction. Alternatively the trapped rubber may be in the form of a separate ring, with the retaining ring forming a carrier between the bush and the seal face member. The bush can be of split form and wrapped in layers of reinforced rubber to hold it together.

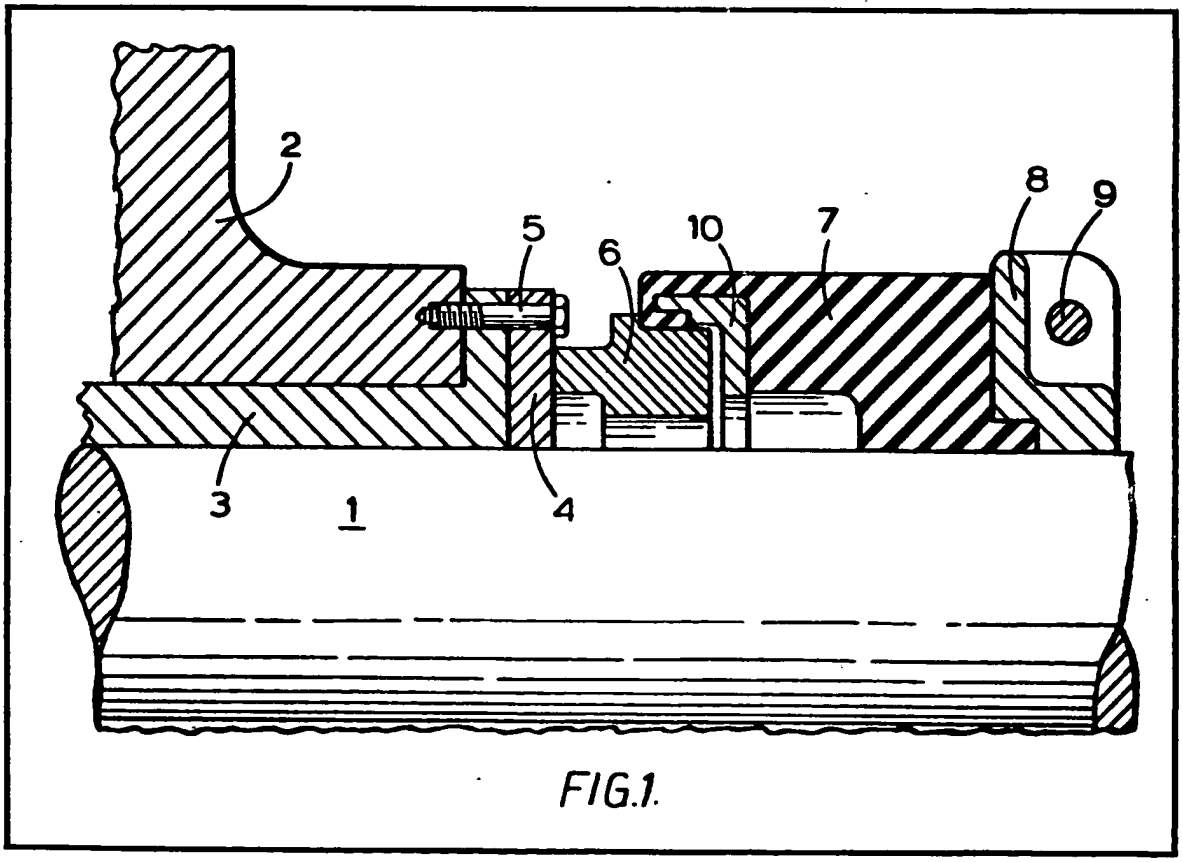

FIG.1.

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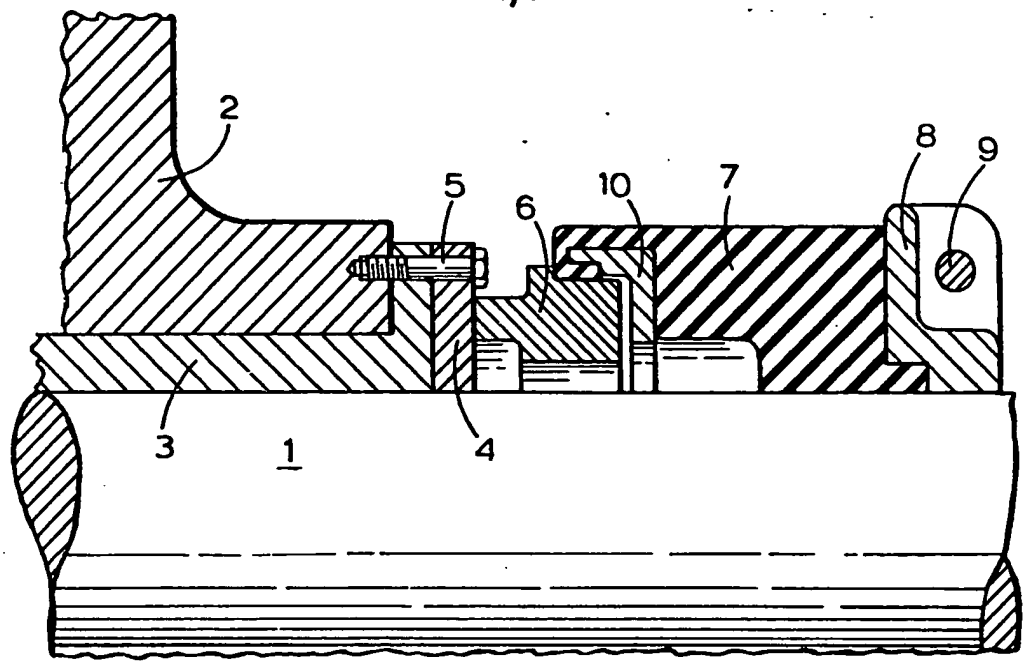

FIG.1.

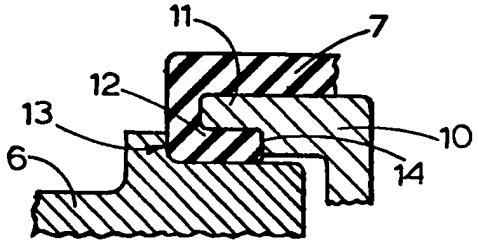

FIG.2.

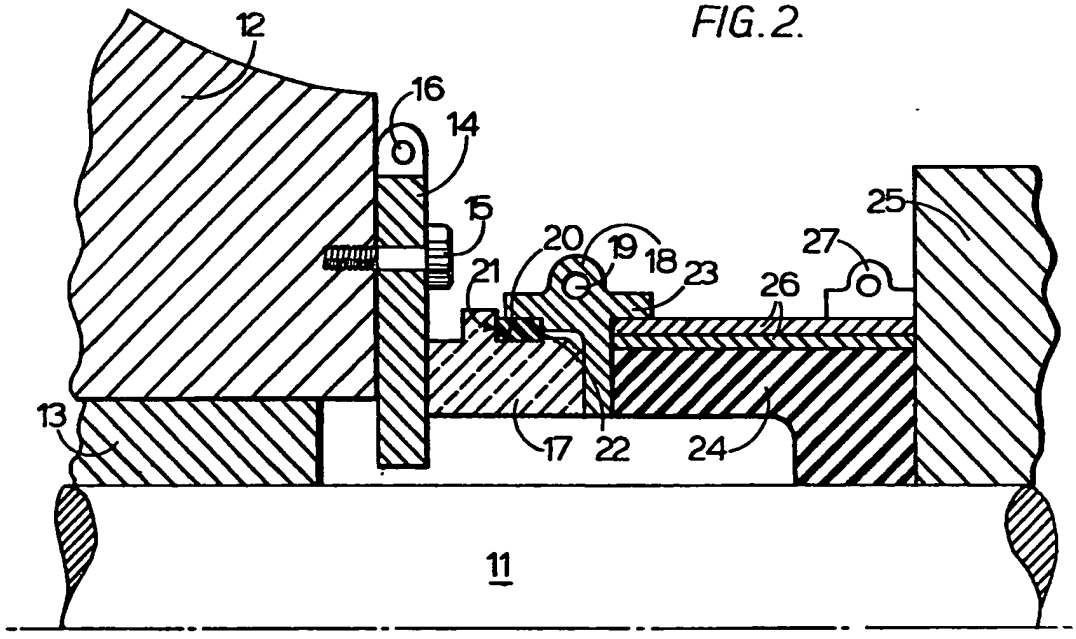

FIG.3.

SPECIFICATION

Shaft seals

This invention relates to shaft seals, primarily but not exclusively to seals of marine propeller shaft stern tubes.

For small and medium-sized ships it is known to construct a propeller shaft seal based on an axially compressed rubber bush. An example of such a seal is that disclosed in British Patent Specification No. 823 167. In that known layout the bush carries a metal wearing insert that makes rubbing contact with a stationary ring.

In a further development of that construction, disclosed in our British Patent Specification No. 1 235 272, the bush is of interrupted form by the provision of a cut through it, so that it can be assembled onto a shaft without access to the end of that shaft. The cut is of a configuration such that the pressure within the bush tends to seal the cut faces together.

In accordance with the invention forming the subject of our Patent Specification No. 986 217 and its Patent of Addition No. 1 099 688 a bellows connection between a seal face member and its associated axially fixed components can be formed in situ, again without access to the end of the shaft, by spirally wrapping a composite metal and rubber-impregnated fabric strip. Such a construction is suitable for very large diameter stern seals, but is rather too complex for smaller seals.

The aim of the present invention is to provide a seal construction in which a rubber bush is used but in which the wearing element or seal face member is replaceable with the minimum of problems.

According to the invention there is proposed a rotary mechanical face seal assembly comprising a rigid seal face member or insert mounted at one end of a rubber bush of which the other end is axially anchored in a manner so that axial compression of the rubber bush produces the necessary axial thrust on the insert to urge it into rubbing contact with a co-operating relatively rotating seat, in which the end of the bush that acts on the insert carries a retaining ring placed so that it encloses a part of the insert, with the interposition of an annular portion of rubber, and means being provided to cause compression of this portion to exert an inward radial force on the insert.

This inward force is primarily of value where the insert, after the maximum permissible wear, is to be replaced. It can be replaced without access to the end of the shaft by using a slit replacement insert, for example in two semicircular halves (in a manner known in itself). The inward radial force of the rubber urges the two halves tightly together whilst at the same time forming a sufficiently yielding support to allow their rubbing faces to align themselves in a common plane.

Some embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which:–

Figure 1 is a section through a ship's stern shaft seal embodying the invention;

Figure 2 shows part of the seal of Fig. 1 to a larger scale; and

Figure 3 is a section similar to Fig. 1 but showing a second embodiment.

Referring first to Figs. 1 and 2, a ship's propeller shaft 1 passes out through a stern frame 2, guided by a bearing bush, 3. A wear plate 4 is bolted on to the end of the stern frame assembly with bolts 5. A rotating seal unit takes the form of a seal face member or wearing insert 6 carried in one end of a rubber bush 7 of which the other end is clamped onto the shaft and driven by a clamp 8 secured by tangential bolts 9. Moulded into the end of the rubber bush that receives the insert 6 is a metal reinforcing ring 10 of L-shaped cross-section. The ring 10 has a radially inwardly extending flange and an axially extending flange, the shape of which is shown to a larger scale in Fig. 2. The purpose of the ring is to reinforce the rubber bush 7 in the region where it receives the seal face member 6 and it will be seen that the rubber extends around the reduced-thickness tip 11 of the ring 10, as indicated at 12. This annular portion 12 thus lies between the inside of the tip 11 of the ring and the outside of part of the insert 6. A shoulder 13 on the insert 6 abuts against the portion 12 of the rubber bush, and the opposite end of this portion 12 abuts against a shoulder 14 on the ring 10, where its reduced-thickness tip joins the remainder of its axially extending flange.

It will be appreciated that the ring 8 is clamped to the shaft 1 at a point such that the rubber bush 7 is under significant axial compression and urges the seal face member 6 into rubbing contact with the wear plate 4 to form a seal. The axial thrust is transmitted from the bush 7 to the member 6 through the portion 12, trapped between the shoulders 13 and 14, and so this portion tends to be compressed axially. As it is constrained by the ring 10 against radial outward expansion it therefore tends to expand radially inwards, tightening its grip on the member 6.

The seal face member or insert 6 may be made of any of the conventional materials e.g. carbon or metal. The chief value of the gripping action on it, obtained by the combination of the rubber bush and the reinforcing ring, lies in the case where the member 6 is of split construction, in that it supports the individual segments firmly but resiliently, squeezing them together to eliminate leakage between their abutting ends and allowing them to align themselves to provide a truly flat common

rubbing face without steps at the joints.

In the embodiment shown in Fig. 3 the rubber which is compressed to grip the insert is separate from the rubber of the bush. A propeller shaft 11 extends through a stern frame 12 of a ship and is carried in a bearing 13. A stationary wearing ring 14 is secured to the stern frame by screws 15 and is split into two halves for ease of assembly and replacement; the halves are held together by tangential bolts (not shown), passing through holes of which one is visible at 16. Against this ring 14 runs a seal face member or insert 17 which is likewise split into two arcuate halves; it is received in a counterbore in the front end of an annular carrier 18 which is again split, the halves being secured together by tangential bolts (not shown) passing through holes 19. Between the carrier 18 and the insert 17 there is a rubber ring 20 of rectangular cross-section, its axial length being greater than its radial thickness. The insert 17 is an interference fit in the ring 20 which is trapped between a shoulder 21 on the insert and a shoulder 22 on the carrier 18.

The carrier 18 has a rearwardly extending flange 23 by means of which the carrier fits over the front end of a hollow cylindrical rubber bush 24, the rear end of which abuts against the propeller, shown at 25.

The bush 24 is of split form and is of axial length, in relation to the space available, such that when the other components are fitted, the bush is axially compressed and consequently exerts a thrust against the insert 17, through the carrier 18 and rubber ring 20, to keep the insert in rubbing contact with the wearing ring 14. This axial thrust, ransmitted through the ring 20, compresses it axially and consequently expands it radially, and as it cannot expand outwards, it applies a radial inward squeeze to the insert 17, as in the earlier embodiment.

In order to hold the split rubber bush 24 together, and to give it resistance to outward expansion, the bush is wrapped in several layers 26 of reinforced rubber sheet, using a contact adhesive to hold it in position. A split clamp 27 holds the tail end of this wrapping securely together, whilst its front end is held by the flange 23 on the carrier 18. Alternatively the sections of the split bush 24 may be secured together by some other means to produce a fluid-tight joint, for example by means of an adhesive.

The invention is still useful where the member 6 or 17 is in one piece. A shaft seal may be installed initially with a one-piece member 6 or 17 but when that becomes worn it can be removed by breaking or cutting it after releasing the clamp 8 and sliding back the rubber bush or after removing the carrier 18) without requiring access to the end of the shaft. It can then be replaced by a new seal face member or insert made up of two or more arcuate segments.

It will be understood that where we refer above, and in the claims, to a rubber bush or a rubber ring, the bush or ring may be of any suitable elastomeric material, natural or synthetic, having the required properties. Also, in the embodiment of Figs. 1 and 2, the ring 10 need not be embedded in the rubber but could be at least partially exposed.

CLAIMS

1. A rotary mechanical face seal assembly comprising a rigid seal face member or insert mounted at one end of a rubber bush of which the other end is axially anchored in a manner so that axial compression of the rubber bush produces the necessary axial thrust on the insert to urge it into rubbing contact with a co-operating relatively rotating seat, in which the end of the bush that acts on the insert carries a retaining ring placed so that it encloses a part of the insert, with the interposition of an annular portion of rubber, and means being provided to cause compression of this portion to exert an inward radial force on the insert.

2. A seal assembly according to claim 1 in which the retaining ring is embedded in the rubber of the bush and the said annular portion of rubber is part of the front end of the bush.

3. A seal assembly according to claim 1 or claim 2 in which the retaining ring and the seal face member both have radially extending shoulders between which the said portion is trapped and axially compressed by the said axial thrust, resulting in a radial expansion of the said portion which produces the said inward radial force.

4. A seal assembly according to any one of claims 1 to 3 in which the retaining ring has an L-shaped cross-section, with an axially extending flange enclosing part of the insert, and a radially inwardly extending flange.

5. A seal assembly according to claim 1 in which the retaining ring is in the form of an annular carrier with a rear face engaging the said one end of the bush and a front face receiving the seal face member or insert with the interposition of a rubber ring.

6. A seal assembly according to claim 5 in which the rubber ring is trapped between radial faces on the carrier and the seal face member or insert in a manner such that the axial thrust is transmitted through the ring so as to cause axial compression and consequent radial expansion of the ring to provide the said inward radial force.

7. A seal assembly according to any one of claims 1 to 6 in which the rubber bush is of split form and is wrapped in layers of reinforced rubber sheet secured to it adhesively.

8. A rotary mechanical face seal assembly substantially as described with reference to

Figs. 1 and 2 of the accompanying drawings.

9. A rotary mechanical face seal assembly substantially as described with reference to Fig. 3 of the accompanying drawings.

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